Amendments to the Specification:

Please replace the paragraph beginning on page 3 line 8 with the following amended paragraph:

--The system supports fast distance estimation from a point to the ~~tooth~~ tooth's surface. This capability is needed for rapid collision detection. It also supports smoothing of the tooth surface – for noise reduction. Such rapid collision detection may support real-time manipulation of the teeth for treatment. For example, a user moves a tooth, and the tooth stops when it ~~came~~ comes in contact with another tooth.--

Please replace the paragraph beginning on page 3 line 13 with the following amended paragraph:

--The system can also support patching small holes in the model of the teeth that may be generated during the taking of impressions/negative impressions. The system also provides the user with a selectable range of precision in teeth geometry representation.--

Please replace the paragraph beginning on page 4 line 21 with the following amended paragraph:

--Fig. 7 shows an original high-resolution teeth model and various compressed versions of the teeth model using the processes of Figs. [[5-6]] 5-6D.--

Please replace the paragraph beginning on page 5 line 3 with the following amended paragraph:

-- Referring now to FIG. 1A, a representative jaw 101 ~~100~~ includes sixteen teeth, at least some of which are to be moved from an initial tooth arrangement to a final tooth arrangement. To understand how the teeth may be moved, an arbitrary centerline (CL) is drawn through one of the teeth 102. With reference to this centerline (CL), the teeth may be moved in the orthogonal directions represented by axes 104, 106, and 108 (where 104 is the centerline). The centerline may be rotated about the axis 108 (root angulation) and 104 (torque) as indicated by arrows 110 and 112, respectively. Additionally, the tooth may be rotated about the centerline CL~~, as represented by arrow 114,~~. Thus, all possible free-form motions of the tooth can be performed.--

Please replace the paragraph beginning on page 6 line 22 with the following amended paragraph:

-- A plaster cast of the patient's teeth is obtained by well known techniques, such as those described in Graber, Orthodontics: Principle and Practice, Second Edition, Saunders, Philadelphia, 1969, pp. 401-415. After the tooth casting is obtained, the casting is digitally scanned by a scanner, such as a non-contact type laser or destructive scanner or a contact-type scanner, to produce the IDDS. The data set produced by the scanner may be presented in any of a variety of digital formats to ensure compatibility with the software used to manipulate images represented by the data. In addition to the 3D image data gathered by laser scanning or destructive scanning the exposed surfaces of the teeth, a user may wish to gather data about hidden features, such as the roots of the patient's teeth and the patient's jaw bones. This information is used to build a more complete model of the patient's dentition and to show with more accuracy and precision how the teeth will respond to treatment. For example, information about the roots allows modeling of all tooth surfaces, instead of just the crowns, which in turn allows simulation of the relationships between the crowns and the roots as they move during treatment. Information about the patient's jaws and gums also enables a more accurate model of tooth movement during treatment. For example, an x-ray of the patient's jaw bones can assist in identifying ~~ankylose~~ any loose teeth, and an MRI can provide information about the density of the patient's gum tissue. Moreover, information about the relationship between the patient's teeth and other cranial features allows accurate alignment of the teeth with respect to the rest of the head at each of the treatment steps. Data about these hidden features may be gathered from many sources, including 2D and 3D x-ray systems, CT scanners, and magnetic resonance imaging (MRI) systems. Using this data to introduce visually hidden features to the tooth model is described in more detail below.--

Please replace the paragraph beginning on page 21 line 28 with the following amended paragraph:

-- Once the intermediate and final data sets have been created and reviewed by an orthodontist or suitably trained person, the appliances may be fabricated as illustrated in FIG. 10. Common fabrication methods employ a rapid prototyping device 501 ~~200~~ such as a

stereolithography machine. A particularly suitable rapid prototyping machine is Model SLA-250/50 available from 3D System, Valencia, California. The rapid prototyping machine 501 ~~200~~ selectively hardens a liquid or other non-hardened resin into a three-dimensional structure which can be separated from the remaining non-hardened resin, washed, and used either directly as the appliance or indirectly as a mold for producing the appliance. The prototyping machine 501 ~~200~~ receives the individual digital data sets and produces one structure corresponding to each of the desired appliances. Generally, because the rapid prototyping machine 501 ~~200~~ may utilize a resin having non-optimum mechanical properties and which may not be generally acceptable for patient use, the prototyping machine typically is used to produce molds which are, in effect, positive tooth models of each successive stage of the treatment. After the positive models are prepared, a conventional pressure or vacuum molding machine is used to produce the appliances from a more suitable material, such as 0.03 inch thermal forming dental material, available from Tru-Tain Plastics, Rochester, Minnesota 55902. Suitable pressure molding equipment is available under the trade name BIOSTAR from Great Lakes Orthodontics, Ltd., Tonawanda, New York 14150. The molding machine 551 ~~250~~ produces each of the appliances directly from the positive tooth model and the desired material. Suitable vacuum molding machines are available from Raintree Essix, Inc.--

Please replace the paragraph beginning on page 7 line 31 with the following amended paragraph:

-- In step 204, final positions for the upper and lower teeth in a masticatory system of a patient are determined by generating a computer representation of the masticatory system. An occlusion of the upper and lower teeth is computed from the computer representation; and a functional occlusion is computed based on interactions in the computer representation of the masticatory system. The occlusion may be determined by generating a set of ideal models of the teeth. Each ideal model in the set of ideal models is an abstract model of idealized teeth placement that is customized to the patient's teeth, as discussed below. After applying the ideal model to the computer representation, ~~and~~ the position of the teeth is optimized to fit the ideal model. The ideal model may be specified by one or more arch forms, or may be specified using various features associated with the teeth..--

Please replace the paragraph beginning on page 9 line 25 with the following amended paragraph:

-- In one embodiment of Fig. 5, data points are separated into groups. A U-curve with a U-knot vector is interpolated through each separate group. Next, one or more V-curves are generated by moving along each of the U-curves for a given knot value. The V-curve is formed by interpolating through these data points. The V-curves intersect the U-curves at points of constant u. A new set of U-curves that are constant in v is obtained by connecting points of constant v along the V-curves. A network of curves and its relationship to the original data points can then be generated. The only curves that are drawn are either curves of constant u or constant v, and so the regions marked out by them are rectangular in u, v-space and can be represented at patches which also mark out rectangular domains in u, v-space. A patch representation is generated from the network to arrive at a full surface description. More details on the surface fitting are discussed in pages 101-110 of Alan Watt and Mark Watt, Advanced Animation and Rendering Techniques (Addison-Wesley Publishing Company, Menlo Park, California).--

Please replace the paragraph beginning on page 10 line 4 with the following amended paragraph:

--Fig. 6A shows a flowchart for a process to create an MxN curve network associated with a tooth. First, the process determines M, the number of slices corresponding to meridian lines crossing the tooth (step 240). Next, the process calculates tangent values for a plurality of planes intersecting with the tooth to define a curve associated with one side of a slice (step 242). One or more sample points and sample tangent values for the sample points are selected (step 244) and the length of the curve is computed (step 246). Next, the process of Fig. [[6]] 6A divides the length of the curve the N and generates points associated with the MxN curve network (step 248).--

Please replace the paragraph beginning on page 10 line 4 with the following amended paragraph:

Please replace the paragraph beginning on page 10 line 28 with the following amended paragraph:

--Next, the process 300 selects the number of meridians M. M can range between 20-40. Also, the process 300 selects the number of points on each meridian N. N ~~is~~ typically ranges between 2/3M to M. A set of M half planes 0, ..., (M-1) is created: each half plane goes through the tooth z-axis, and the plane i forms an angle (2*PI/M)*i with the tooth x-axis (step 302). Exemplary half planes are shown in Fig. 6C.--

Please replace the paragraph beginning on page 11 line 3 with the following amended paragraph:

--For each meridian line, a length L is determined and S is determined as a function of L/(N-1) (step 306). From a starting point, the process 300 proceeds along the meridian line and <u>finds</u> points p0 = A, p1, ..., p[N-1] = B such that the point p[n+1] is at the distance S from p[n] along the meridian. Eventually, an M*N list of points in 3D space is generated and saved (step 308). The points can be saved as short integer values rather than floating point values.--

Please replace the paragraph beginning on page 14 line 5 with the following amended paragraph:

--Next, the process of Fig. 9 determines the largest R-value for all points of intersection of the ray with the tooth (step 512). The value determined in step 512 is stored in ~~an~~ a table (step 514), and the process is iterated until all phi and theta values have been processed. In one embodiment, for each value stored in the nodes of Phi x Theta grid, only one byte of data is saved to disk. Minimum and maximum values of R are computed. The interval [minR, maxR] is divided into 255 parts. Any R may be approximated using the following formula:

BYTE b = (BYTE)(255 * (R – minR) / (maxR – minR)); --

Please replace the paragraph beginning on page 22 line 33 with the following amended paragraph:

-- FIG. 11 is a simplified block diagram of a data processing system <u>600</u> ~~300~~ that may be used to develop orthodontic treatment plans. The data processing system <u>600</u> ~~300~~ typically includes at least one processor <u>602</u> ~~302~~ that communicates with a number of peripheral

devices via bus subsystem 604 ~~304~~. These peripheral devices typically include a storage subsystem 606 ~~306~~ (memory subsystem 608 ~~308~~ and file storage subsystem 614 ~~314~~), a set of user interface input and output devices 618 ~~318~~, and an interface to outside networks 616 ~~318~~, including the public switched telephone network. This interface is shown schematically as "Modems and Network Interface" block 616 ~~316~~, and is coupled to corresponding interface devices in other data processing systems via communication network interface 624 ~~324~~. Data processing system 600 ~~300~~ could be a terminal or a low-end personal computer or a high-end personal computer, workstation or mainframe.--

Please replace the paragraph beginning on page 23 line 21 with the following amended paragraph:

-- Storage subsystem 606 ~~306~~ maintains the basic required programming and data constructs. The program modules discussed above are typically stored in storage subsystem 606 ~~306.~~ Storage subsystem 606 ~~306~~ typically comprises memory subsystem 608 ~~308~~ and file storage subsystem 614 ~~314~~.--

Please replace the paragraph beginning on page 23 line 25 with the following amended paragraph:

--Memory subsystem 608 ~~308~~ typically includes a number of memories including a main random access memory (RAM) 610 ~~310~~ for storage of instructions and data during program execution and a read only memory (ROM) 612 ~~312~~ in which fixed instructions are stored. In the case of Macintosh-compatible personal computers the ROM would include portions of the operating system; in the case of IBM-compatible personal computers, this would include the BIOS (basic input/output system).--

Please replace the paragraph beginning on page 23 line 31 with the following amended paragraph:

--File storage subsystem 614 ~~314~~ provides persistent (non-volatile) storage for program and data files, and typically includes at least one hard disk drive and at least one floppy disk drive (with associated removable media). There may also be other devices such as a CD-

ROM drive and optical drives (all with their associated removable media). Additionally, the system may include drives of the type with removable media cartridges. The removable media cartridges may, for example be hard disk cartridges, such as those marketed by Syquest and others, and flexible disk cartridges, such as those marketed by Iomega. One or more of the drives may be located at a remote location, such as in a server on a local area network or at a site on the Internet's World Wide Web.--

Please replace the paragraph beginning on page 24 line 14 with the following amended paragraph:

-- Bus subsystem 604 ~~304~~ is shown schematically as a single bus, but a typical system has a number of buses such as a local bus and one or more expansion buses (e.g., ADB, SCSI, ISA, EISA, MCA, NuBus, or PCI), as well as serial and parallel ports. Network connections are usually established through a device such as a network adapter on one of these expansion buses or a modem on a serial port. The client computer may be a desktop system or a portable system.--

Please replace the paragraph beginning on page 24 line 20 with the following amended paragraph:

--Scanner 620 ~~320~~ is responsible for scanning casts of the patient's teeth obtained either from the patient or from an orthodontist and providing the scanned digital data set information to data processing system 600 ~~300~~ for further processing. In a distributed environment, scanner 620 ~~320~~ may be located at a remote location and communicate scanned digital data set information to data processing system 600 ~~300~~ via network interface 624 ~~324~~.--

Please replace the paragraph beginning on page 24 line 25 with the following amended paragraph:

--Fabrication machine 622 ~~322~~ fabricates dental appliances based on intermediate and final data set information received from data processing system 600 ~~300~~. In a distributed environment, fabrication machine 622 ~~322~~ may be located at a remote location and receive data set information from data processing system 600 ~~300~~ via network interface 624 ~~324~~.--